REMARKS

Present Status of the Application

The Office Action rejected claims 1-23 under 35 U.S.C. 103(a) as being unpatentable over Taubin et al. "ACM, published July 1998, pages 1-10 (hereinafter Taubin); in view of Hoppe (U. S. Patent 6,046,744). Claims 1-23 remain pending in the present application, and reconsideration of those claims is respectfully requested.

About Inventorship

Inventor "Kai-Shu Yang" has been corrected to "Shu-Kai Yang", who is the same inventor but in typo-error.

Discussion of Claim Rejections under 35 USC 103

The Office Action rejected claims 1-23 under 35 U.S.C. 103(a) as being unpatentable over Taubin in view of Hoppe With respect to independent claim 1, the present invention recites the features about constructing the clusters from each vertex in a single resolution mesh, which is the original resolution.

1. With respect to independent claim 1, the present invention performs the expansion operation, so as to form the cluster. The expansion operation is repeated to form the forest. Then, the cluster in the forest is simplified. The Operation can be seen in FIG. 6, wherein the cluster c(u) and the cluster c(v0) are connected by the expansion operation. Then, in FIG. 7, the cluster in forest is simplified.

With respect to claims 2-5, one example of expansion operation to form the forest is recited.

In other words, the present invention is to simplify a mesh from high resolution into low resolution in progressive step without losing main information. The claimed invention is not disclosed by the prior art references.

2. The comparisons with prior art references are as follows:

In general, Taubin does not propose the formula to construct triangle-strip trees of the lowest cost. The proposed algorithm includes a method to construct vertex trees of the lowest cost; and

Hoppe's edge-collapsing algorithm simplifies triangles beside a single edge in one step. Taubin's algorithm collects the triangle strips formed by the edges that are collapsible in Hoppe's algorithm. Many triangle strips may be connected to be triangle-strip trees. The proposed algorithm collects the collapsible edges to form vertex trees that are called vertex clusters.

The combination of Taubin with Hoppe failed to disclose the features of the claimed invention.

For the detail, the goal of mesh-simplification algorithms is to reduce the amount of vertices and polygons of meshes with an assumption that preserves the shape features of meshes. If the simplification operation is invertible, the simplified mesh can be refined with the invert operations called refinements progressively. The mesh that can be refined is called a progressive mesh. It is the production of a mesh simplification algorithm.

The common basic idea of mesh-simplification algorithms that get good effects is to find

flat areas along edges on a mesh. "Flat" means that merging endpoints of as edge do not cause any rough change of the shape. This idea is presented by Hoppe Fig. 13(or see FIG 3 of Admitted prior art). But the progressive mesh produced by Hoppe's algorithm recovers one edge and increase one or two triangle in one step only. It is too slow for real-time rendering.

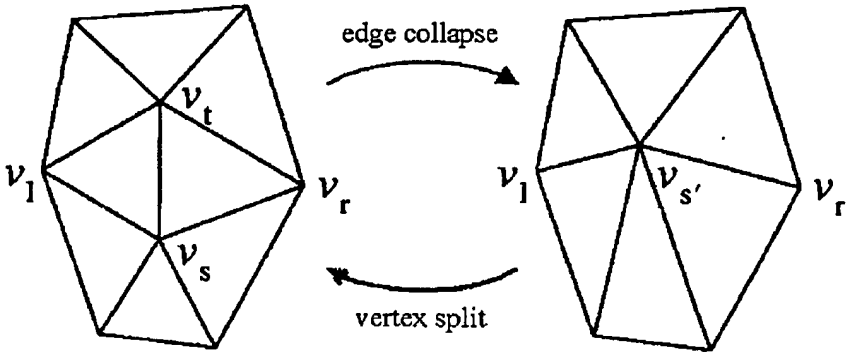
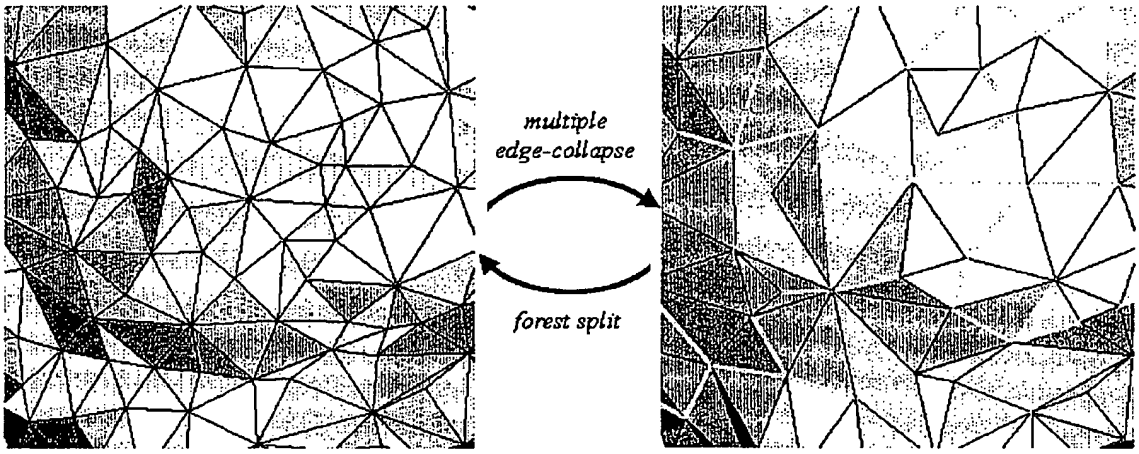


Figure A1 (FIG 3 of Admitted Prior Art): Hoppe's edge-collapsing operation.

If an algorithm deals with more vertices, triangles, or edges instead of only one edge in a simplification step, the produced progressive mesh has fewer refinement steps and is more efficient. Taubin's idea is to collect the triangles beside the collapsible edges in Hoppe's algorithm, forms triangle strips, then collapses the strips in one step. The invert operation of the strip collapsing is called forest-split in Taubin's papers. The forest is a rest of triangle-strip trees. The forest-split operation refines a mesh by unfolding the collapsed strips. Fig. A2 is originated from Fig. 4A and 4B of Taubin.



Figures 4A, 4B: Taubin's forest-split operation.

Note : Yellow(Lightly shaded area) is the folding region ;
Yellow line (light thick line) is the folding line

The forest in the proposed algorithm of the present invention is a rest of vertex trees that connected by collapsible edges. A vertex tree is a vertex cluster. The forest-clustering operation is to merge all vertices in the trees to their root vertices.

In the present invention, the claimed invention is different from Taubin's idea. The proposed algorithm in the present invention collects the collapsible edges and their endpoints to form vertex trees, not triangle-strip trees. The method to construct vertex trees of the lowest cost is shown in FIG. 6. It is "growth of minimal cost trees". Starting from discrete edges, try to connect the trees by joining new edges and detect the cost, find the linkage of the lowest const. The edge-joining operation is called an expansion in the claimed algorithm.

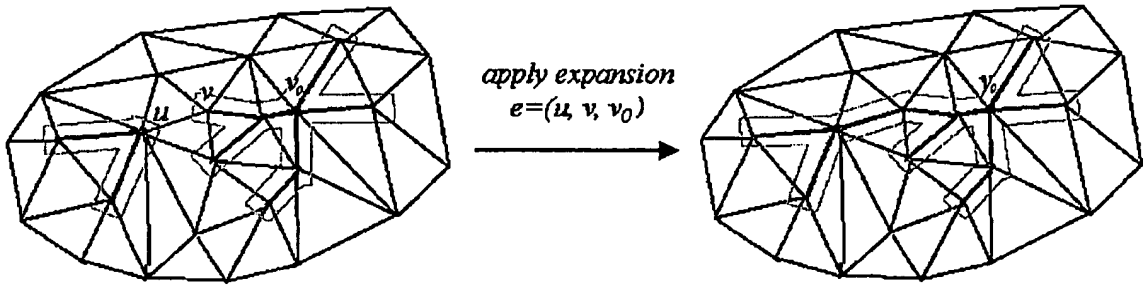


FIG. 6: The construction of vertex trees (Invention).
Note: Red line is the tree trunk

After constructing the vertex trees of the lowest cost, the mesh-simplification step is to merge all vertices in the trees to their root vertices. As shown in FIG. 7, it reduces many triangles in single step. The amount of reduced vertices or triangles can be controlled in the tree growth.

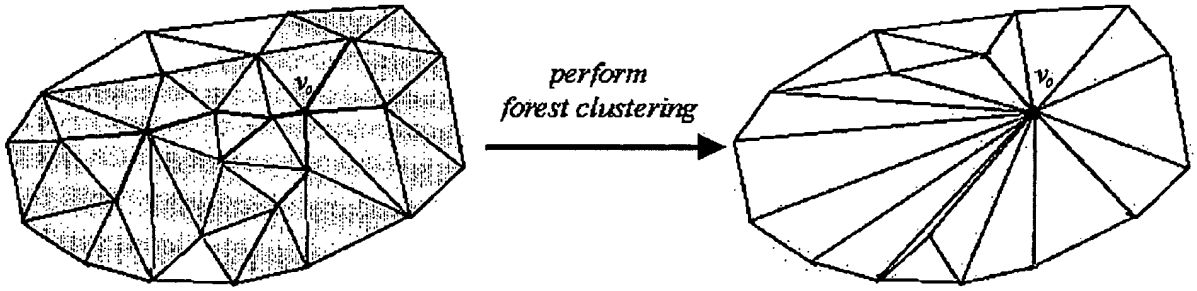


FIG. 7: The forest clustering operation (Invention).

Pick a piece of paper for demonstration. Taubin's algorithm is to fold the paper along some strip areas. The claimed algorithm is to pinch the paper according to some points on the paper. Both algorithms make some areas of the paper disappear. Only the areas on the same papers can be folded by Taubin's algorithm. But areas or corners of discrete papers can be pinched by the claimed algorithm.

3. Further still, the algorithm of the present invention has produced the unexpected result in nonobviousness to improve the efficiency.

> Hoppe's algorithm reduces one or two triangles in one simplification step. The progressive mesh produced by the algorithm increases one or two triangles in one refinement step. It is not efficient enough for real-time rendering.
>
> Taubin's algorithm collapses triangle trips to simplify a mesh, unfolds the strips to refine a mesh. There is a nature limitation that only manifold areas on the mesh can be collapsed.

The limitation of Taubin's algorithm makes it unpractical because modelers build meshes by intersecting and welding components, which does not disclose features of the claimed invention. For example, an ant-head model could be created by intersecting a sphere with two pipes. Some models are built in a front part and a back part, or top part and bottom part. Then modelers weld the vertices of two parts to form a complete model, but not all vertices between the parts are welded well. Taubin's algorithm can not handle the models like those, but the claimed algorithm can handle them well.

For at least the foregoing reasons, Applicant respectfully submits that independent claim 1 patently define over the prior art references, and should be allowed. For at least the same reasons, dependent claims 2-23 patently define over the prior art references as well, wherein claims 2-5 are further distinguishable over prior art references.

Application No.: 09/920,035 **Docket No.: JCLA6567**

CONCLUSION

For at least the foregoing reasons, it is believed that all the pending claims 1-23 of the invention patently define over the prior art and are in proper condition for allowance. If the Examiner believes that a telephone conference would expedite the examination of the above-identified patent application, the Examiner is invited to call the undersigned.

Respectfully submitted,
J.C. PATENTS

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Jiawei Huang
Registration No. 43,330

4 Venture, Suite 250
Irvine, CA 92618
Tel.: (949) 660-0761
Fax: (949) 660-0809